

HEF4538B

Dual precision monostable multivibrator

Rev. 05 — 4 March 2009

Product data sheet

1. General description

The HEF4538B is a dual retriggerable-resettable monostable multivibrator. Each multivibrator has an active LOW trigger/retrigger input ($n\bar{A}$), an active HIGH trigger/retrigger input (nB), an overriding active LOW direct reset input ($n\bar{C}\bar{D}$), an output (nQ) and its complement ($n\bar{Q}$), and two pins (nR_{EXT}/C_{EXT} , and nC_{EXT} , always connected to ground) for connecting the external timing components C_{EXT} and R_{EXT} . Typical pulse width variation over the specified temperature range is $\pm 0.2\%$.

The multivibrator may be triggered by either the positive or the negative edges of the input pulse and will produce an accurate output pulse with a pulse width range of 10 μs to infinity. The duration and accuracy of the output pulse are determined by the external timing components C_{EXT} and R_{EXT} . The output pulse width (t_W) is equal to $R_{EXT} \times C_{EXT}$. The linear design techniques in LOC MOS (Local Oxide CMOS) guarantee precise control of the output pulse width. A LOW level at $n\bar{C}\bar{D}$ terminates the output pulse immediately. The trigger inputs' Schmitt trigger action makes the circuit highly tolerant of slower rise and fall times.

It operates over a recommended V_{DD} power supply range of 3 V to 15 V referenced to V_{SS} (usually ground). Unused inputs must be connected to V_{DD} , V_{SS} , or another input. It is also suitable for use over the industrial ($-40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$) and automotive ($-40\text{ }^\circ\text{C}$ to $+125\text{ }^\circ\text{C}$) temperature ranges.

2. Features

- Tolerant of slow trigger rise and fall times
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Operates across the automotive temperature range $-40\text{ }^\circ\text{C}$ to $+125\text{ }^\circ\text{C}$
- Complies with JEDEC standard JESD 13-B
- ESD protection:
 - ◆ HBM JESD22-A114E exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V

3. Applications

- Automotive and industrial

4. Ordering information

Table 1. Ordering information
 All types operate from -40°C to $+125^{\circ}\text{C}$.

Type number	Package		Version
	Name	Description	
HEF4538BP	DIP16	plastic dual in-line package; 16 leads (300 mil)	SOT38-4
HEF4538BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

5. Functional diagram

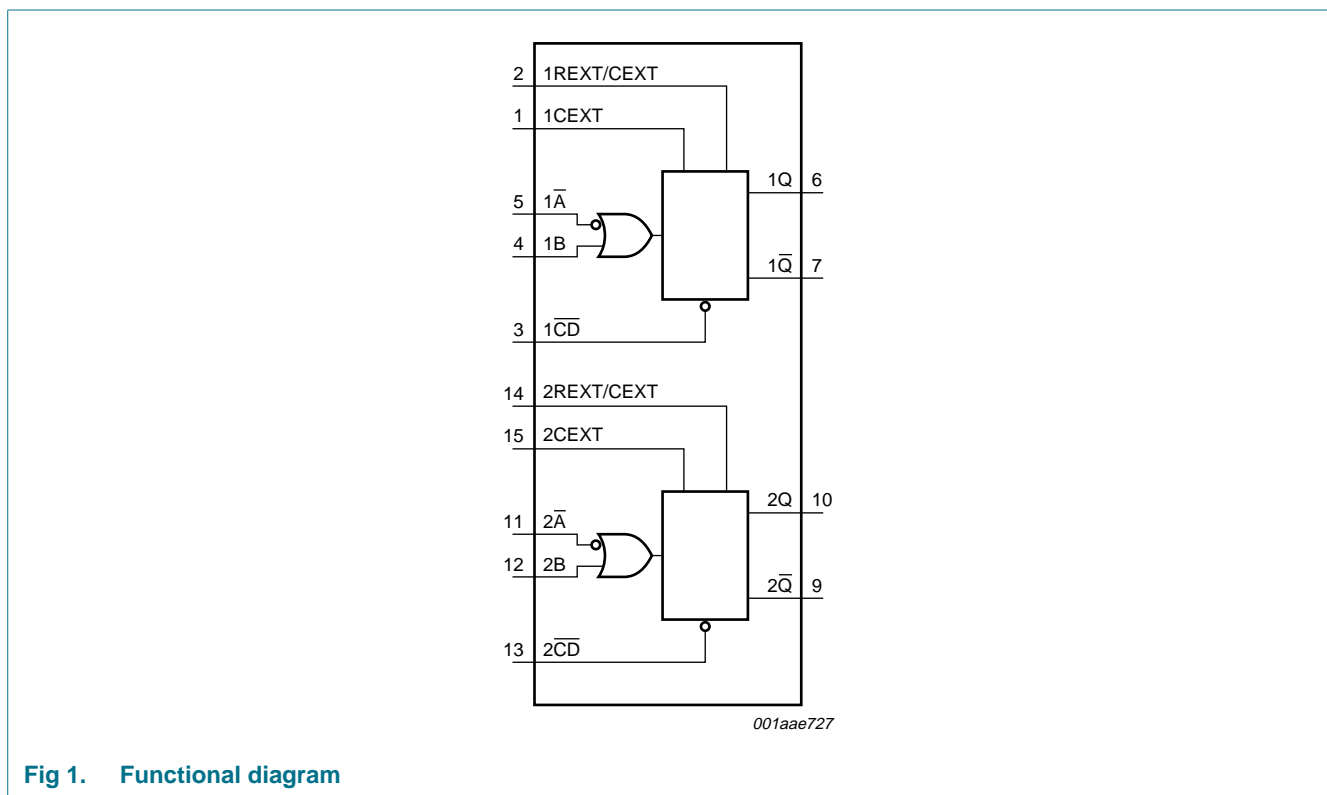


Fig 1. Functional diagram

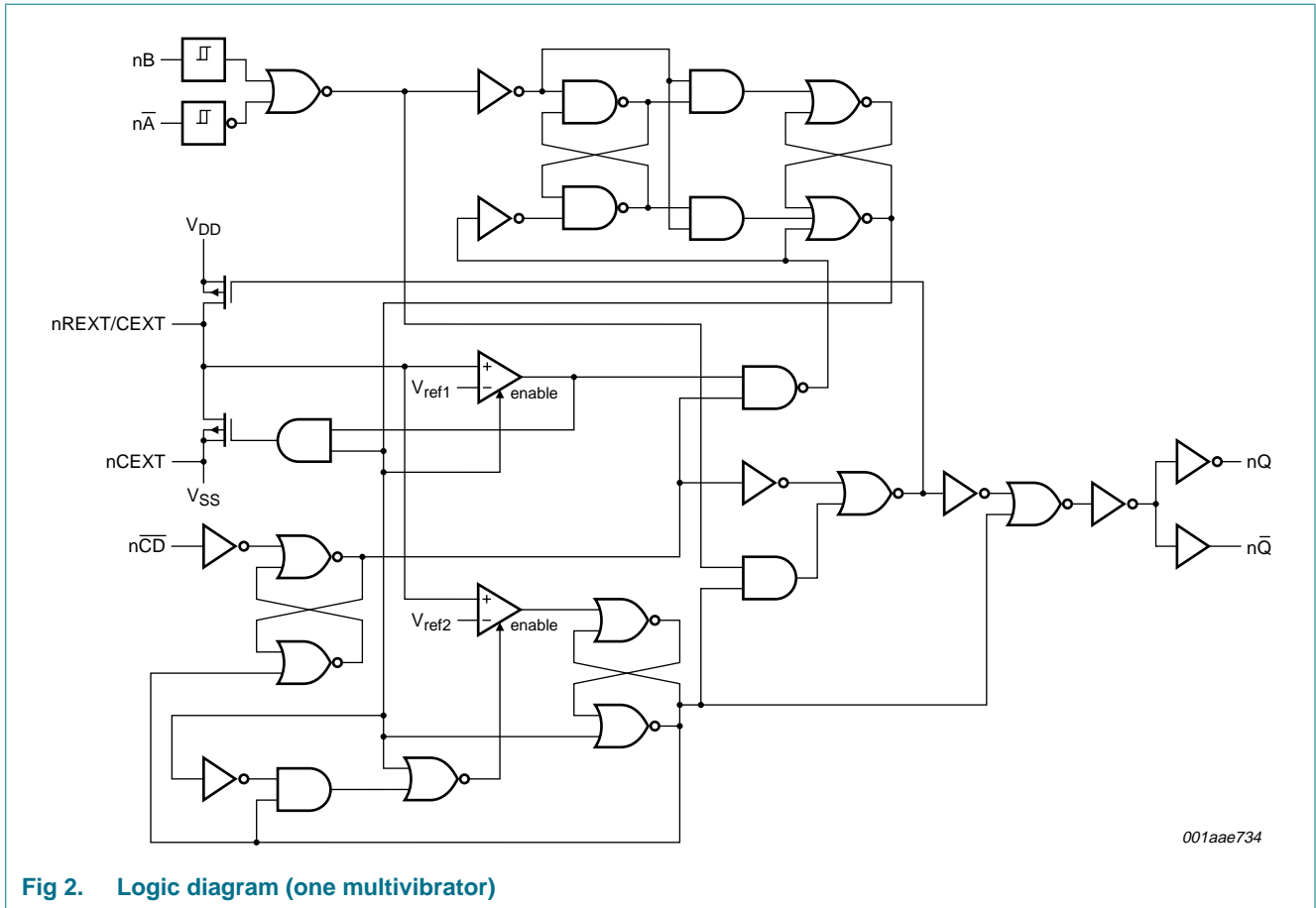


Fig 2. Logic diagram (one multivibrator)

6. Pinning information

6.1 Pinning

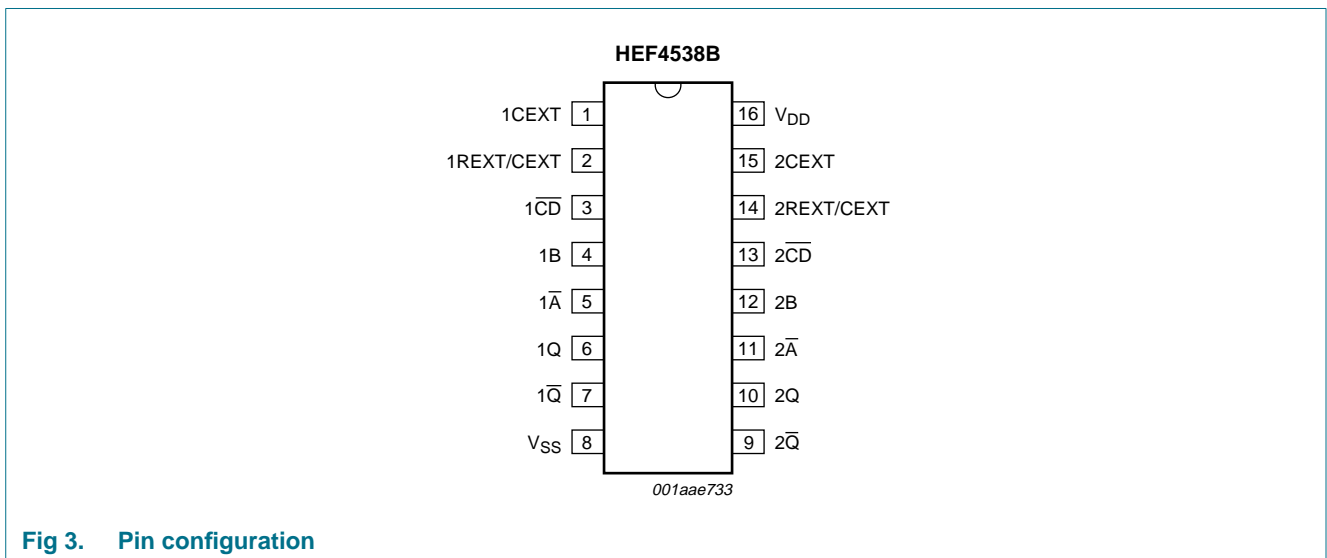


Fig 3. Pin configuration





6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
1CEXT, 2CEXT	1, 15	external capacitor connection (always connected to ground)
1REXT/CEXT, 2REXT/CEXT	2, 14	external capacitor/resistor connection
1 \overline{CD} , 2 \overline{CD}	3, 13	direct reset input (active LOW)
1B, 2B	4, 12	input (LOW-to-HIGH triggered)
1 \overline{A} , 2 \overline{A}	5, 11	input (HIGH-to-LOW triggered)
1Q, 2Q	6, 10	output
1 \overline{Q} , 2 \overline{Q}	7, 9	complementary output (active LOW)
V _{SS}	8	ground supply voltage
V _{DD}	16	supply voltage


7. Functional description


Table 3. Function table

Inputs			Outputs	
n \overline{A}	nB	n \overline{CD}	nQ	n \overline{Q}
↓	L	H		
H	↑	H		
X	X	L	L	H

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care;

↑ = positive-going transition; ↓ = negative-going transition;

 = one HIGH level output pulse, with the pulse width determined by C_{EXT} and R_{EXT};

 = one LOW level output pulse, with the pulse width determined by C_{EXT} and R_{EXT}.

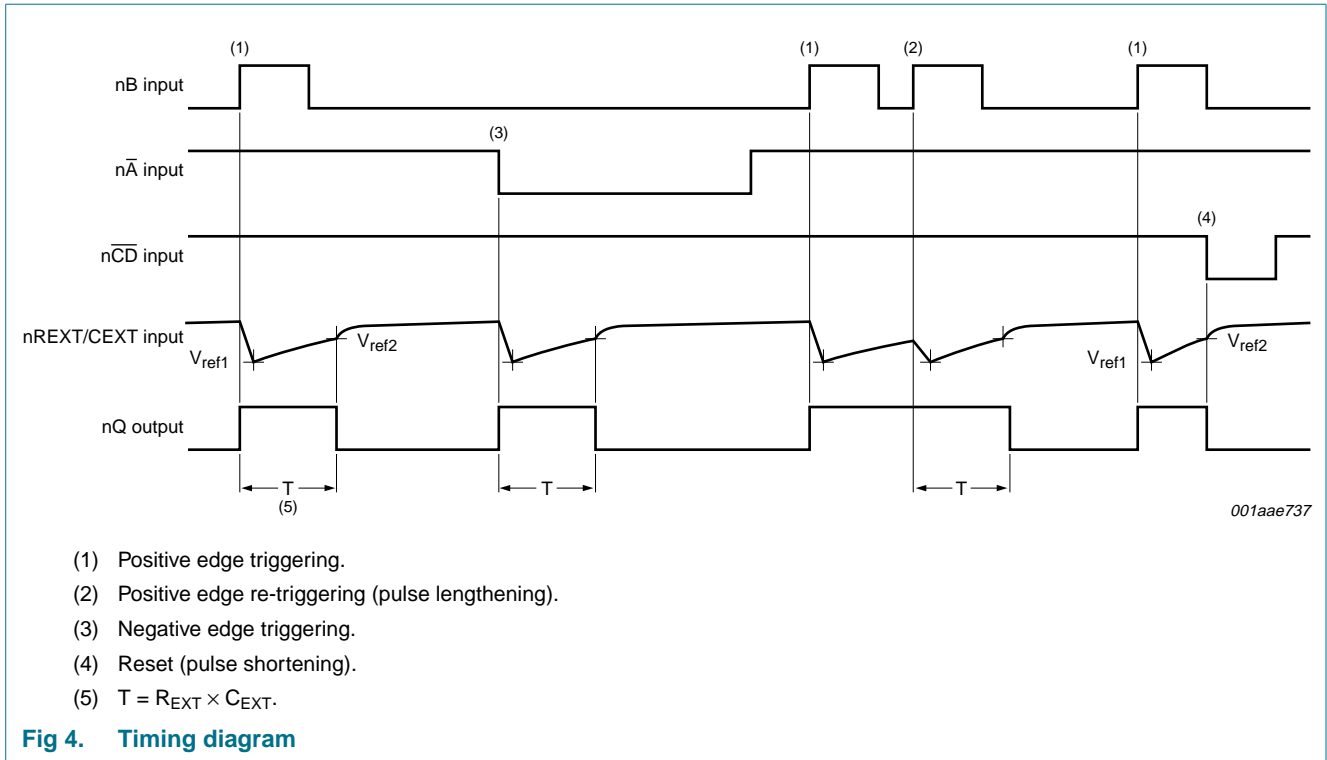


Fig 4. Timing diagram

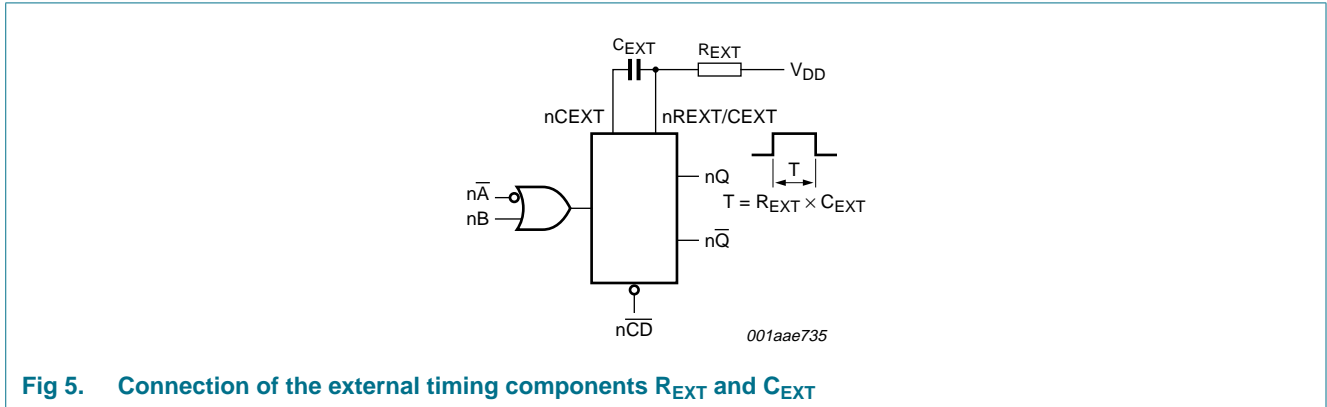


Fig 5. Connection of the external timing components R_{EXT} and C_{EXT}

8. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to $V_{SS} = 0$ V (ground)

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DD}	supply voltage		-0.5	+18	V
I_{IK}	input clamping current	$V_I < -0.5$ V or $V_I > V_{DD} + 0.5$ V	-	± 10	mA
V_I	input voltage		-0.5	$V_{DD} + 0.5$	V
I_{OK}	output clamping current	$V_I < -0.5$ V or $V_I > V_{DD} + 0.5$ V	-	± 10	mA
$I_{I/O}$	input/output current		-	± 10	mA
I_{DD}	supply current		-	50	mA
T_{stg}	storage temperature		-65	+150	$^{\circ}$ C

Table 4. Limiting values ...continued

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to $V_{SS} = 0\text{ V}$ (ground)

Symbol	Parameter	Conditions	Min	Max	Unit
T_{amb}	ambient temperature		-40	+125	°C
P_{tot}	total power dissipation	$T_{amb} = -40\text{ °C to }+125\text{ °C}$			
		DIP16 package	[1] -	750	mW
		SO16 package	[2] -	500	mW
P	power dissipation	per output	-	100	mW

[1] For DIP16 package: P_{tot} derates linearly with 12 mW/K above 70 °C.

[2] For SO16 package: P_{tot} derates linearly with 8 mW/K above 70 °C.

9. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DD}	supply voltage		3	-	15	V
V_I	input voltage		0	-	V_{DD}	V
T_{amb}	ambient temperature	in free air	-40	-	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{DD} = 5\text{ V}$	-	-	3.75	ns/V
		$V_{DD} = 10\text{ V}$	-	-	0.5	ns/V
		$V_{DD} = 15\text{ V}$	-	-	0.08	ns/V

10. Static characteristics

Table 6. Static characteristics

$V_{SS} = 0\text{ V}$; $V_I = V_{SS}$ or V_{DD} unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	$T_{amb} = -40\text{ °C}$		$T_{amb} = 25\text{ °C}$		$T_{amb} = 85\text{ °C}$		$T_{amb} = 125\text{ °C}$		Unit
				Min	Max	Min	Max	Min	Max	Min	Max	
V_{IH}	HIGH-level input voltage	$ I_O < 1\text{ }\mu\text{A}$	5 V	3.5	-	3.5	-	3.5	-	3.5	-	V
			10 V	7.0	-	7.0	-	7.0	-	7.0	-	V
			15 V	11.0	-	11.0	-	11.0	-	11.0	-	V
V_{IL}	LOW-level input voltage	$ I_O < 1\text{ }\mu\text{A}$	5 V	-	1.5	-	1.5	-	1.5	-	1.5	V
			10 V	-	3.0	-	3.0	-	3.0	-	3.0	V
			15 V	-	4.0	-	4.0	-	4.0	-	4.0	V
V_{OH}	HIGH-level output voltage	$ I_O < 1\text{ }\mu\text{A}$	5 V	4.95	-	4.95	-	4.95	-	4.95	-	V
			10 V	9.95	-	9.95	-	9.95	-	9.95	-	V
			15 V	14.95	-	14.95	-	14.95	-	14.95	-	V
V_{OL}	LOW-level output voltage	$ I_O < 1\text{ }\mu\text{A}$	5 V	-	0.05	-	0.05	-	0.05	-	0.05	V
			10 V	-	0.05	-	0.05	-	0.05	-	0.05	V
			15 V	-	0.05	-	0.05	-	0.05	-	0.05	V

Table 6. Static characteristics ...continued
 $V_{SS} = 0\text{ V}$; $V_I = V_{SS}$ or V_{DD} unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	$T_{amb} = -40\text{ }^\circ\text{C}$		$T_{amb} = 25\text{ }^\circ\text{C}$		$T_{amb} = 85\text{ }^\circ\text{C}$		$T_{amb} = 125\text{ }^\circ\text{C}$		Unit
				Min	Max	Min	Max	Min	Max	Min	Max	
I_{OH}	HIGH-level output current	$V_O = 2.5\text{ V}$	5 V	-1.7	-	-1.4	-	-1.1	-	-1.1	-	mA
		$V_O = 4.6\text{ V}$	5 V	-0.64	-	-0.5	-	-0.36	-	-0.36	-	mA
		$V_O = 9.5\text{ V}$	10 V	-1.6	-	-1.3	-	-0.9	-	-0.9	-	mA
		$V_O = 13.5\text{ V}$	15 V	-4.2	-	-3.4	-	-2.4	-	-2.4	-	mA
I_{OL}	LOW-level output current	$V_O = 0.4\text{ V}$	5 V	0.64	-	0.5	-	0.36	-	0.36	-	mA
		$V_O = 0.5\text{ V}$	10 V	1.6	-	1.3	-	0.9	-	0.9	-	mA
		$V_O = 1.5\text{ V}$	15 V	4.2	-	3.4	-	2.4	-	2.4	-	mA
I_I	input leakage current	nREXT/CEXT	15 V	-	± 0.1	-	± 0.1	-	± 1.0	-	± 1.0	μA
C_I	input capacitance		-	-	-	7.5	-	-	-	-	pF	

Table 7. Typical static characteristics
 $V_{SS} = 0\text{ V}$; $V_I = V_{SS}$ or V_{DD} ; $T_{amb} = +25\text{ }^\circ\text{C}$.

Symbol	Parameter	Conditions	V_{DD}	Typ	Unit
I_{DD}	supply current	active state	5 V	55	μA
			10 V	150	μA
			15 V	220	μA
C_I	input capacitance	nREXT/CEXT	-	15	pF

[1] Only one monostable is switching: for the specified current during the output pulse (output Q is HIGH).

11. Dynamic characteristics

Table 8. Dynamic characteristics
 $V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ }^\circ\text{C}$; for test circuit see [Figure 11](#).

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula ^[1]	Min	Typ	Max	Unit
t_{PHL}	HIGH to LOW propagation delay	$n\bar{A}$, nB to nQ; see Figure 6	5 V	$193\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	220	440	ns
			10 V	$74\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	85	190	ns
			15 V	$52\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	60	120	ns
		$n\bar{C}\bar{D}$ to nQ; see Figure 6	5 V	$98\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	125	250	ns
			10 V	$44\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	55	110	ns
			15 V	$32\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	40	80	ns
t_{PLH}	LOW to HIGH propagation delay	$n\bar{A}$, nB to nQ; see Figure 6	5 V	$173\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	200	460	ns
			10 V	$79\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	90	180	ns
			15 V	$52\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	60	120	ns
		$n\bar{C}\bar{D}$ to nQ; see Figure 6	5 V	$98\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	125	250	ns
			10 V	$44\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	55	110	ns
			15 V	$32\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	40	80	ns

Table 8. Dynamic characteristics ...continued
 $V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$; for test circuit see [Figure 11](#).

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula ^[1]	Min	Typ	Max	Unit
t_{rec}	recovery time	n \overline{CD} to n \overline{A} , nB; see Figure 7	5 V		-	20	40	ns
			10 V		-	10	20	ns
			15 V		-	5	10	ns
t_{rtrig}	retrigger time	nQ, n \overline{Q} to n \overline{A} , nB; see Figure 7	5 V		0	-	-	ns
			10 V		0	-	-	ns
			15 V		0	-	-	ns
t_W	pulse width	n \overline{A} LOW; minimum width; see Figure 7	5 V		90	45	-	ns
			10 V		30	15	-	ns
			15 V		24	12	-	ns
		nB HIGH; minimum width; see Figure 7	5 V		50	25	-	ns
			10 V		24	12	-	ns
			15 V		20	10	-	ns
		n \overline{CD} LOW; minimum width; see Figure 7	5 V		55	25	-	ns
			10 V		25	12	-	ns
			15 V		20	10	-	ns
		nQ or n \overline{Q} ; $R_{EXT} = 100\text{ k}\Omega$; $C_{EXT} = 2.0\text{ nF}$; see Figure 7	5 V		218	230	242	μs
			10 V		213	224	235	μs
			15 V		211	223	234	μs
		nQ or n \overline{Q} ; $R_{EXT} = 100\text{ k}\Omega$; $C_{EXT} = 0.1\text{ }\mu\text{F}$; see Figure 7	5 V		10.3	10.8	11.3	ms
			10 V		10.2	10.7	11.2	ms
			15 V		10.1	10.6	11.1	ms
nQ or n \overline{Q} ; $R_{EXT} = 100\text{ k}\Omega$; $C_{EXT} = 10\text{ }\mu\text{F}$; see Figure 7	5 V		1.01	1.09	1.11	ms		
	10 V		0.99	1.04	1.09	ms		
	15 V		0.99	1.04	1.09	ms		
Δt_W	pulse width variation	nQ or n \overline{Q} variation over temperature range; see Figure 8	5 V		-	± 0.2	-	%
			10 V		-	± 0.2	-	%
			15 V		-	± 0.2	-	%
		nQ or n \overline{Q} variation over V_{DD} voltage range 5 V to 15 V; see Figure 9			-	± 1.5	-	%
R_{EXT}	external timing resistor	nQ or n \overline{Q} variation between monostables in the same device; $R_{EXT} = 100\text{ k}\Omega$; $C_{EXT} = 2\text{ nF}$ to $10\text{ }\mu\text{F}$	5 V		-	± 1	-	%
			10 V		-	± 1	-	%
			15 V		-	± 1	-	%
R_{EXT}	external timing resistor				5	-	[2]	k Ω
C_{EXT}	external timing capacitor				2000	-	no limits	pF

[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown (C_L in pF).

[2] The maximum permissible resistance R_{EXT} , which holds the specified accuracy of t_W (nQ, n \overline{Q} output), depends on the leakage current of the capacitor C_{EXT} and the leakage of the HEF4538B.

12. Waveforms

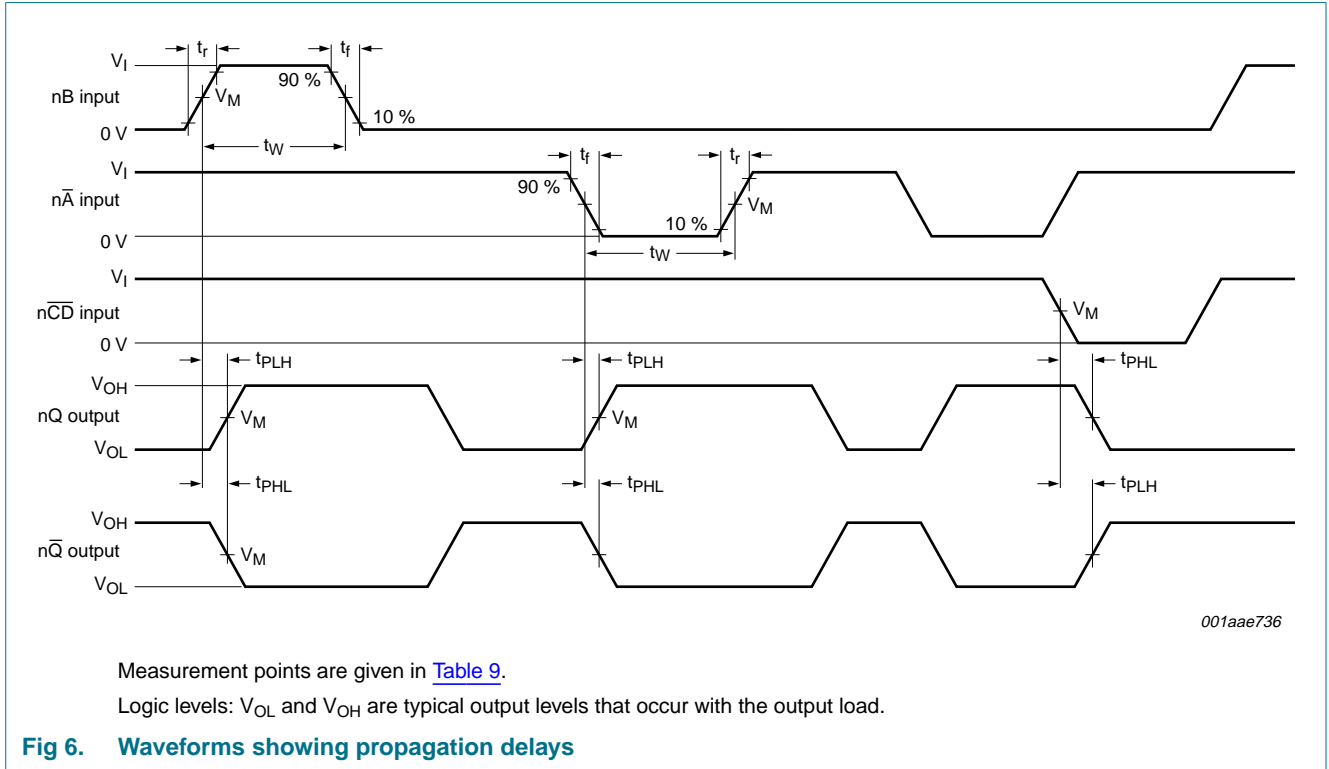
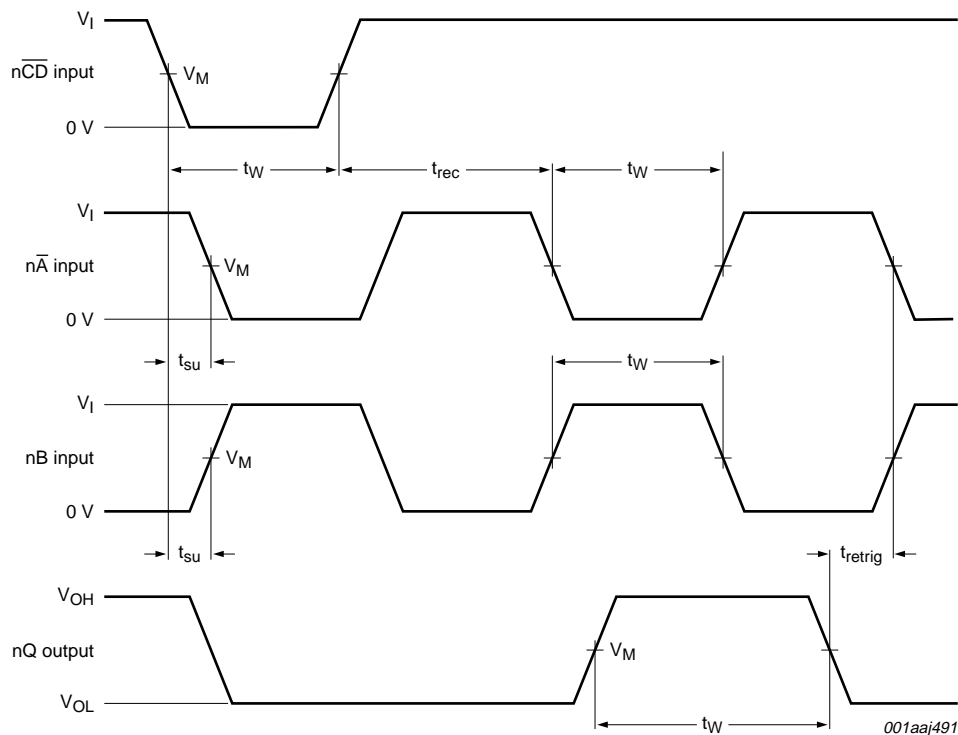


Fig 6. Waveforms showing propagation delays

Table 9. Measurement points

Supply voltage	Input	Output
V_{DD}	V_M	V_M
5 V to 15 V	$0.5V_{DD}$	$0.5V_{DD}$

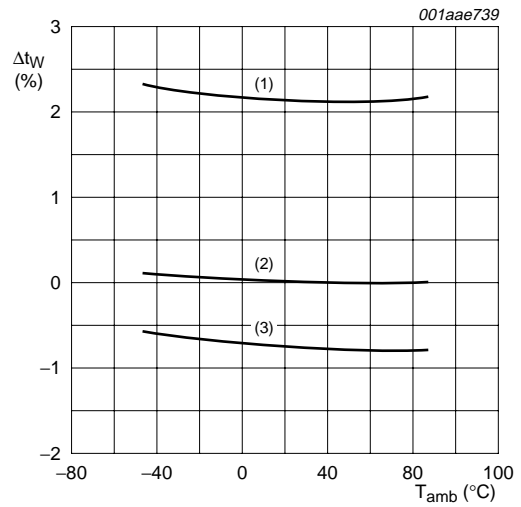
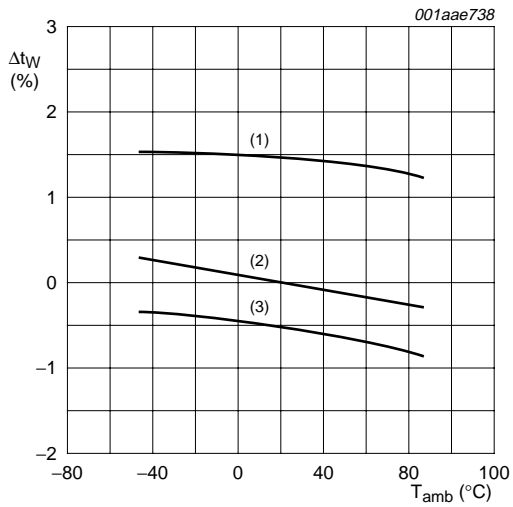


Measurement points are given in [Table 9](#).

Set-up and recovery times are shown as positive values but may be specified as negative values.

Logic levels: V_{OL} and V_{OH} are typical output levels that occur with the output load.

Fig 7. Waveforms showing minimum \overline{nA} , \overline{nB} , and \overline{nQ} pulse widths and set-up, recovery and retrigger times



a. $R_{EXT} = 100\text{ k}\Omega$; $C_{EXT} = 100\text{ nF}$

b. $R_{EXT} = 100\text{ k}\Omega$; $C_{EXT} = 2\text{ nF}$

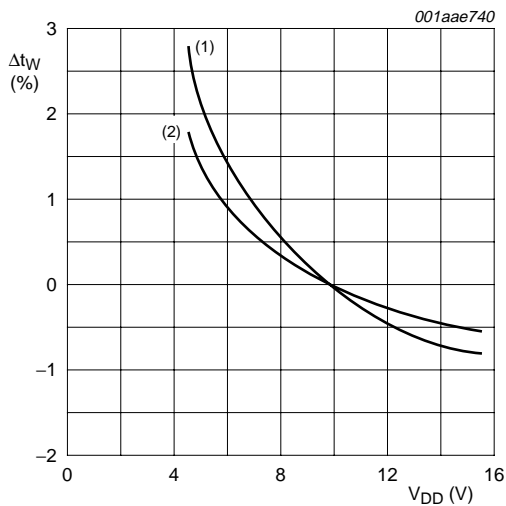
(1) $V_{DD} = 5\text{ V}$.

(2) $V_{DD} = 10\text{ V}$.

(3) $V_{DD} = 15\text{ V}$.

$\Delta t_W = 0\%$ at $V_{DD} = 10\text{ V}$ and $T_{amb} = 25\text{ }^\circ\text{C}$

Fig 8. Typical normalized change in output pulse width as a function of ambient temperature

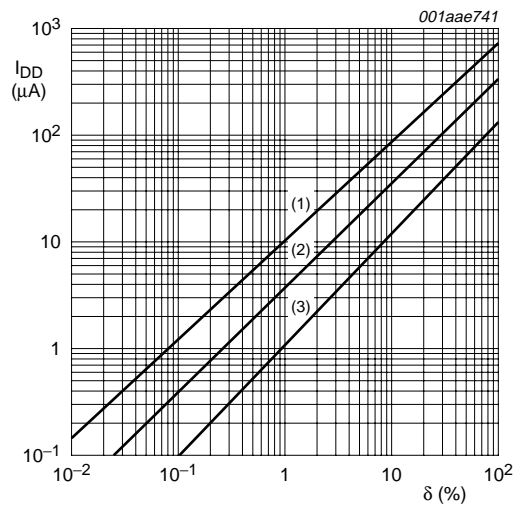


$T_{amb} = 25\text{ }^\circ\text{C}$; $\Delta t_W = 0\%$ at $V_{DD} = 10\text{ V}$; $R_{EXT} = 100\text{ k}\Omega$

(1) $C_{EXT} = 2\text{ nF}$.

(2) $C_{EXT} = 100\text{ nF}$.

Fig 9. Typical normalized change in output pulse width as a function of the supply voltage



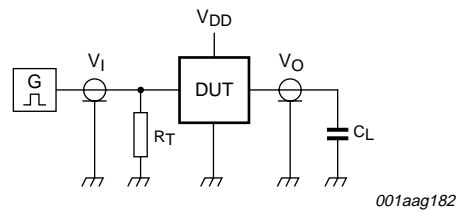
$R_{EXT} = 100\text{ k}\Omega$; $C_{EXT} = 100\text{ nF}$; $C_L = 50\text{ pF}$;
one monostable multivibrator switching only

(1) $V_{DD} = 15\text{ V}$.

(2) $V_{DD} = 10\text{ V}$.

(3) $V_{DD} = 5\text{ V}$.

Fig 10. Total supply current as a function of the output duty factor



Test data is given in [Table 10](#).

Definitions for test circuit:

C_L = load capacitance including jig and probe capacitance.

R_T = termination resistance should be equal to the output impedance Z_o of the pulse generator.

Fig 11. Test circuit

Table 10. Test data

Supply voltage	Input		Load
V_{DD}	V_I	t_r, t_f	C_L
5 V to 15 V	V_{SS} or V_{DD}	≤ 20 ns	50 pF

13. Package outline

DIP16: plastic dual in-line package; 16 leads (300 mil)

SOT38-4

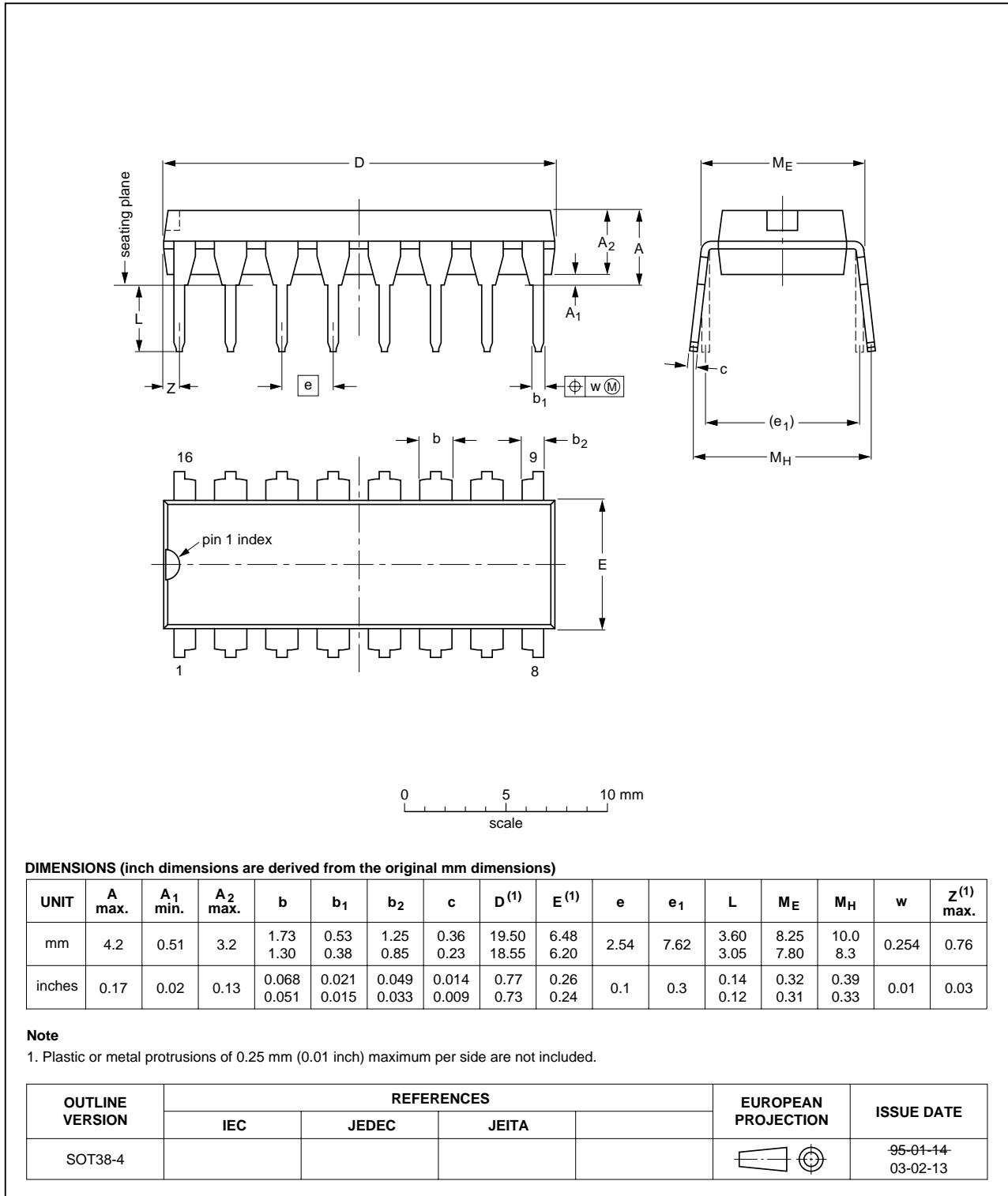


Fig 12. Package outline SOT38-4 (DIP16)

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

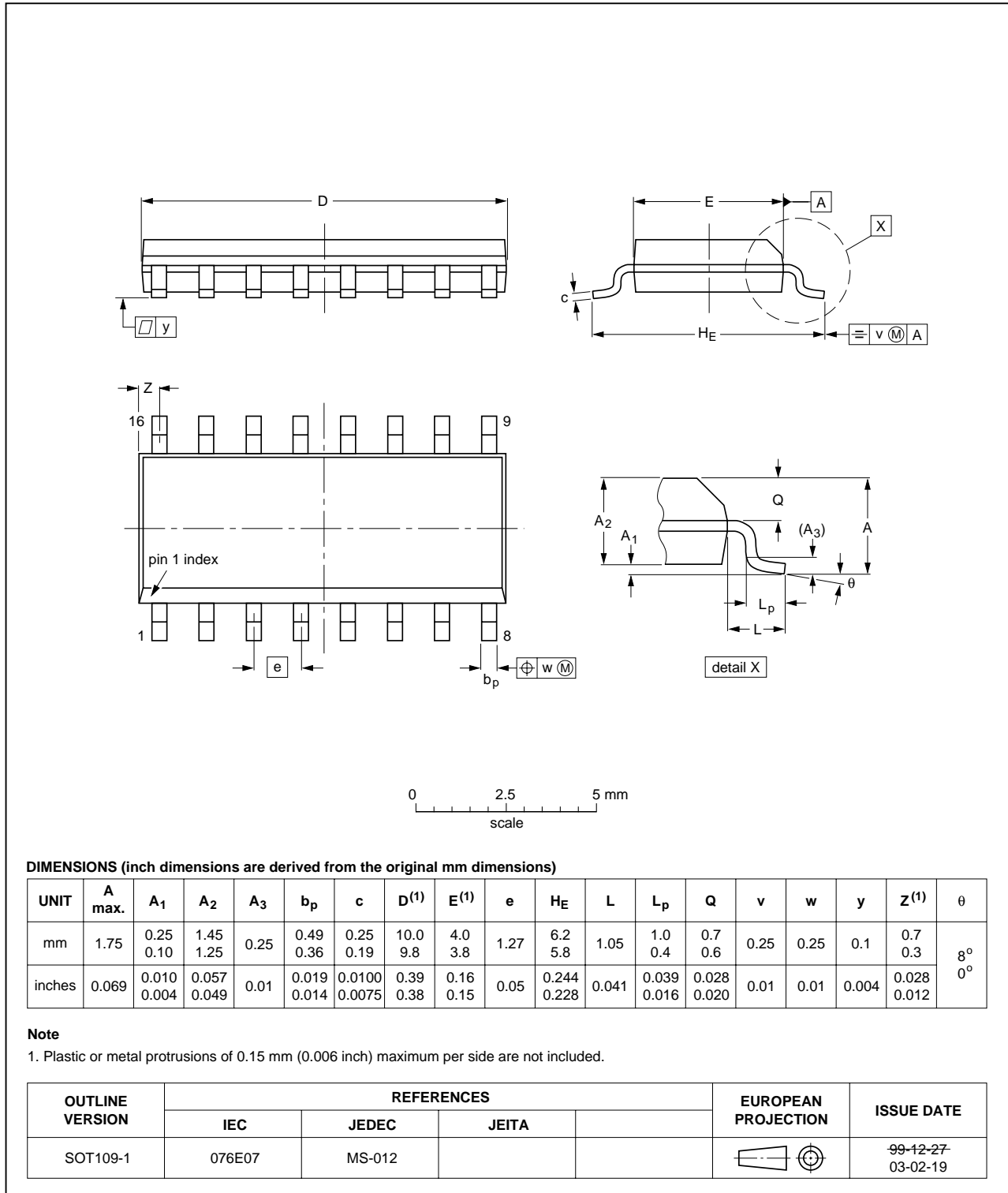


Fig 13. Package outline SOT109-1 (SO16)

14. Abbreviations

Table 11. Abbreviations

Acronym	Description
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model

15. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4538B_5	20090304	Product data sheet	-	HEF4538B_4
Modifications:		<ul style="list-style-type: none"> Update to clamp current conditions in Table 4 "Limiting values" Update to Figure 7 "Waveforms showing minimum nA, nB, and nQ pulse widths and set-up, recovery and retrigger times" 		
HEF4538B_4	20090206	Product data sheet	-	HEF4538B_CNV_3
HEF4538B_CNV_3	19950101	Product specification	-	HEF4538B_CNV_2
HEF4538B_CNV_2	19950101	Product specification	-	-

16. Legal information

16.1 Data sheet status

Document status ^{[1][2]}	Product status ^[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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